The objective of this study was to evaluate the effect of Holstein strain on plasma metabolome to understand physiological adaptation at grazing of Holstein cows of 2 genetic origins: American (HFA, n = 8; 588 kg live weight, 2.50 BCS) and New Zealand (HFNZ, n = 8, 524 kg live weight, 2.60 BCS) during early and mid-lactation. Multiparous cows were used. Cows were fed 64% pastures, 31% of concentrate and 5% on average. Cows produced 33.0 vs. 30.4 ± 2.0 kg/d of milk for HFA and HFNZ respectively (P = 0.02), without differences between genetic strains in body condition score (P = 0.10). Plasma were collected at 21 and 180 d in milk and analyzed using a targeted metabolomic approach through a gas chromatography/time-of-flight mass spectrometry method. A total of 172 metabolites were quantified. According to principal component analysis, data were clustered in 2 groups corresponding to DIM and a partial least square discriminant analysis classification model was obtained (R² = 0.95; Q² = 0.40) being oxoproline, p-tolyl glucuronide, 5-hydroxynorvaline, erythritol and isoleucine the 5 metabolites with the highest score of variable importance in the projection (VIP score >2.0 in all cases). Univariate analysis (false discovery rate-corrected ANOVA) showed 68 metabolites differing (adj-P < 0.05) between strains and 5 that tended (adj-P < 0.10) to be affected by the interaction between strain and DIM, but none of the metabolites were affected by DIM. Most of these differing metabolites belonged to amino acid metabolism (n = 26), fatty acids (n = 11), kidney deficiency pathways (n = 4), bile acids (n = 5) and the others composed single metabolite classes. There was not a clear trend on the effect of strain for most of the metabolite families as — on average— within each group (AA, fatty acid, kidney deficiency pathways, bile acids), half of the metabolites had a fold change >1.0 and half <1.0 for HFNZ compared with HFA cows. However, with the exception of linoleic and stearic acid, all fatty acids were increased in HFNZ compared with HFA cows (e.g., palmitoleic, arachidonic acids, adj-P < 0.05, fold change >1.0 in all cases). The effect of genetic strain on metabolic adaptations to pastoral constrains seems to rely, at least in part, on nitrogen metabolism.

Key Words: Holstein strains, grazing, metabolomics

21 Simultaneous minimization of diet costs and phosphorus excretion on dairy farms. A. F. White* and L. E. Moraes, The Ohio State University, Columbus, OH.

The study objective was to develop a mathematical programming model capable of simultaneously optimizing diets with different weights for least cost (LC) and least on farm P-balance (LP). The ration ingredients, herd composition, and animal categories were designed to represent the Jersey herd of the Ohio State University Waterman Dairy Center. The model constraints were set to meet the current recommendations of the NRC (2001), and additional constraints based on industry recommended practices were specified to limit the inclusion of specific feeds in the diet. Using OpenSolver (v.2.9.0, opensolver.org), 3 objective functions were individually optimized to (1) minimize the diet cost; (2) minimize the excess of P balance in the system, computed as the difference between P excreted and P uptake by forage production on-farm; and (3) minimize the weighted deviations from the values of the 2 previously optimized objective functions. A grid of 100 potential weights were used that varied the size of the effect of each deviation from the given optimization model on the current optimized objective. Total daily feed cost per kg of milk for LC and LP were $0.21 and $0.25 (19% increase with respect to the LC diet), respectively; daily farm P balance per kg milk was 0.9g and 0.3g (67% decrease). Thus, at the extreme points of the weight grid, a substantial decrease in P balance was obtained; however, at a substantial increase in diet costs. The trade-offs between the 2 goals set by the weighting scheme, however, allowed the identification of a set of diets that all met the NRC (2001) requirements while having different costs and determining different P balances on the farm. For example, the weighted goal programming model identified a diet that allowed a 37% reduction of P balance occurring with a 0.4% increase in cost (with respect to LC). These initial reductions in P were generally accompanied by increased forage fed, increase of on-farm corn silage production, and increased purchase of hay. These optimizations suggest a potential use of weighted goal programming as a technique to identify diets that allow a reduction in on-farm P balance with limited effect on whole-farm feed cost.

Key Words: Least cost, least on farm P-balance, mathematical programming, dairy farms, forage fed, increase of on-farm corn silage production, increased purchase of hay.

22 Predictive models for early diagnosis of metritis and clinical cure of dairy cows using behavioral parameters. V. R. Mendoza*, R. C. Chebel1,2, 1Department of Large Animal Clinical Sciences, University of Florida, Gainesville, FL, 2Department of Animal Sciences, Institute of Food and Agricultural Sciences, Gainesville, FL.

Our objectives were to predict the occurrence of metritis and cure from metritis. Holstein animals (n = 564) were fitted with an automated device 21 d prepartum. Cows were examined for metritis (feitid, watery, red/brown uterine discharge) and, at diagnosis (d 0), were paired by parity and severity of metritis [metritis vs. puerperal (rectal temperature >39.5°C)] and were randomly selected to receive ampicillin trihydrate or cefitofus crystalline free acid. Cows that were not diagnosed with any diseases (n = 374) were enrolled in the study. Cure from metritis was defined as the absence of metritic discharge and rectal temperature <39.5°C, 11 d after diagnosis. Rumination, resting, feeding and activity time from 10 d prepartum until 10 d after metritis diagnosis were used. In all models, farm, lactation, re-
tained placenta, vaginal laceration score, stillbirth, male, twins, dystocia, rumination, resting, feeding, and activity time were included. In addition, BCS prepartum and at calving were included in the models to predict the occurrence of metritis, and severity of metritis and BCS at diagnosis were included in the models to predict the probability of cure. The area under the curve (AUC) according to the receiver operator characteristic for the model predicting metritis at 1 [AUC = 0.74, 95% confidence interval (CI) = 0.70, 0.78] and 2 (AUC = 0.78, 95% CI = 0.74, 0.81) DIM were (P < 0.01) acceptable. The models predicting puerperal metritis at 1 (AUC = 0.81, 95% CI = 0.77, 0.84) and 2 (0.82; 95% CI = 0.78, 0.85) DIM were (P < 0.01) excellent. The AUC of the models using behavioral changes peripartum to predict cure at d−1 (0.81; 95% CI = 0.74, 0.87) and 0 (0.81; 95% CI = 0.75, 0.87) relative to diagnosis were (P < 0.01) excellent, as was the AUC of the model using total behavior time on d0 (AUC = 0.82, 95% CI = 0.75, 0.88; P < 0.01). This study demonstrates that behavioral changes peripartum allows for the early diagnosis of metritis and whether cows will be cured from metritis, allowing for the implementation of preventive strategies and earlier decision making regarding metritis treatment.

Key Words: predictive model, metritis, cure

23 Effect of a commercial active dry yeast (CNCM I-1079) on productive and metabolic measures during the periparturient transition. M. R. Steelreath*, H. C. Hung1, R. L. Hiltz1, M. N. Degenshein1, A. Aguilar2, N. Laarman3, and P. Rezamand1, 1Department of Animal and Veterinary Science, University of Idaho, Moscow, ID; 2Lallemand Animal Nutrition, Milwaukee, WI; 3Agricultural Food and Nutritional Science, University of Alberta, Edmonton, AB, Canada.

The periparturient period is a metabolically demanding time for dairy animals because of the increased nutrient requirements for milk yield. The objective of this study was to investigate the effect of feeding a commercial active dry yeast (ADY) in dairy cows on productive and metabolic measures during the periparturient period. Primiparous (n = 33) and multiparous (n = 35) cows were fed a close-up TMR before calving and a lactation TMR postpartum. Three weeks before expected calving time, animals were blocked by parity and BW and then randomly assigned to either control group (CTRL; n = 34) or treatment (ADY; n = 34). The ADY animals received a top-dressed ADY (S. Boulardii, CNCM-I-1079) fed daily at 12.5 g per head (10 × 10⁹ cfu). Blood samples were collected weekly. Milk yield, feed intake, and milk composition data were collected. Plasma/serum samples were analyzed for glucose, nonesterified fatty acid (NEFA), β-hydroxybutyrate (BHB), and haptoglobin (Hpt). Colostrom samples collected within the first 6–10 h after parturition were analyzed for somatic cell count (SCC) and IgG, IgA, IgM concentrations. Data were analyzed using PROC MIXED in SAS with time as a repeated measure. Model included time, parity, treatment, and their interactions. Significance was declared as P ≤ 0.05 and tendency at P < 0.1. The ADY animals produced more milk (39.3 vs. 37.2 ± 2.02 kg/d; P = 0.02), tended to produce more energy-corrected milk (ECM; 35.5 vs. 34.2 ± 1.44 kg/d; P = 0.07), and had a better feed efficiency (ECM/DMI; P = 0.06). There was a treatment × parity × time effect on milk protein percent; the multiparous ADY animals had a greater protein percent wk 2 postpartum (P < 0.01). There was not a difference in plasma glucose, serum NEFA, serum BHB, or colostrom IgG, IgA, and IgM by main effects or their interactions. Multiparous animals had a greater colostrom IgA (1011 vs. 749 ± 38 mg/dL) but a lower SCC (926 vs. 1578 ± 1000/mL). ADY animals had a greater serum Hpt (P = 0.03) while Hpt concentration peaked for all animals wk 1 postpartum. Research is needed to understand the effects of this ADY on metabolism.

Key Words: active dry yeast, periparturient cow, blood metabolites

24 Identifying factors associated with lameness and its impact on productivity in automated milking herds. R. D. Matson1, M. T. M. King1, T. F. Duffield2, D. E. Santschi3, K. Orsel4, E. A. Pajor4, G. B. Penner4, T. Mutsvangwa5, and T. J. DeVries1, 1Department of Animal Biosciences, University of Guelph, Guelph, ON, Canada; 2Department of Population Medicine, University of Guelph, Guelph, ON, Canada; 3Lactanet, Sainte-Anne-de-Bellevue, QC, Canada; 4Faculty of Veterinary Medicine, University of Calgary, Calgary, AB, Canada; 5Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada.

Voluntary milking is critical for success in automated milking systems (AMS); impaired gait (lameness) may negatively affect the ability and desire for cows to milk voluntarily. The objective of this study was to assess the impact lameness has on the productivity of AMS herds and identify factors associated with lameness. From April to September 2019, 76 robot herds were visited, and data on barn design and farm management practices were collected. Data from AMS units were collected, along with milk recording data for the 6 mo period before farm visits. Farms averaged 99 ± 73 lactating cows, 2.3 ± 1.4 robot units/farm, 43.9 ± 9.0 cows/robot, 36.7 ± 4.7 kg/d of milk, a milking frequency of 3.0 ± 0.4×/d, and a herd-average SCC of 198.3 ± 88.1 (×1,000) cells/mL. Thirty percent (minimum of 30 cows/farm) were scored for body condition (BCS 1 = underconditioned to 5 = over conditioned) and gait (1 = sound to 5 = lame); with clinically lame ≥ 3: 28.6 ± 11.7%; and severely lame ≥ 4: 3.0 ± 3.2%. Univariable models were used to screen independent variables (as fixed effects) in mixed-effect linear regression models and variables with P < 0.25 were offered to multivariable models. Clinical lameness was 10.2 percentage points (p.p.) less prevalent on farms with sand bedding (P < 0.01) and tended to be 2.8 p.p. less for each additional time stalls were raked/d (P = 0.07) and 5.7 p.p. lesser for farms that built new barns vs. retrofitting existing barns (P = 0.07). Herd average milk yield/cow decreased with greater prevalence of clinical (−0.1 kg/d for 1 p.p. increase; P = 0.01) and severe lameness (−0.8 kg/d with doubling of prevalence from 3 to 6%; P < 0.01). Milk yield/robot decreased with a greater prevalence of clinical lameness (−7.1 kg/d for 1 p.p. increase; P = 0.01) and severe lameness (−10.2 percentage points (p.p.), with clinically lame ≥ 3: 28.6 ± 11.7%; and severely lame ≥ 4: 3.0 ± 3.2%). The ADY animals had a greater colostrum IgA (1011 vs. 749 ± 38 mg/dL) but a lower IgG, IgA, and IgM by main effects or their interactions. Multiparous animals had a greater protein percent wk 2 postpartum (P < 0.01). There was not a difference in plasma glucose, serum NEFA, serum BHB, or colostrum IgG, IgA, and IgM by main effects or their interactions. Multiparous animals had a greater colostrom IgA (1011 vs. 749 ± 38 mg/dL) but a lower SCC (926 vs. 1578 ± 1000/mL). ADY animals had a greater serum Hpt (P = 0.03) while Hpt concentration peaked for all animals wk 1 postpartum. Research is needed to understand the effects of this ADY on metabolism.

Key Words: automated milking system, lameness, herd management


Multiparous cows are negatively impacted by heat stress when dry, however, the impact of heat stress on pregnant heifers has received less attention. Our goal was to determine if late gestational heat stress abatement improves thermoregulatory responses and milk production of nulliparous heifers. Pregnant heifers were randomly assigned to either heat stress (HT, shade; n = 16) or cooling (CL, shade, soakers, and fans; n = 15) environments during the last 60 of pregnancy (~8 weeks). Rectal temperatures (thermometer), respiration rates (flank movements/min), sweating rates (SR; VapoMeter), and skin temperatures (ST; infrared thermometer) were measured thrice weekly from enrollment to calving. Vaginal temperatures (i-button intra-vaginal device) were measured every 10 min for 7 consecutive days at wk 1, 3, 5, and 7 relative to enrollment. Daily thermoregulatory patterns were assessed by SR and ST measured every 4 h over a 36-h time interval at wk 3, 5, and 7. Milk yield was recorded twice daily for 15 weeks. Data were analyzed by PROC MIXED (repeated measures) with treatment, hour, week, and all possible interactions as fixed effects. Cool heifers had lower (all P ≤ 0.01) rectal temperatures (38.7 vs. 38.9°C), respiration rates (46.3 vs. 59.6 bpm), and ST (34.8 vs. 35.3°C) relative to HT heifers. Sweating rates were lower in the CL vs. HT heifers from wk 2 to 8 (P < 0.0001). Vaginal temperatures were lower (P = 0.002) in CL relative to HT heifers during wk 1, 3, and 7, particularly between 1000 h to 1400 h and 2200 h to 0500 h. When measured continuously over a 36-h time inter-
val ST and SR were lower \( (P \leq 0.006) \) in CL heifers for all weeks; notably, CL heifer ST was reduced overnight and SR was reduced during the daytime. Cooled heifers had higher milk yield \( (3.7 \text{ kg/d}, P = 0.05) \) when compared with HT heifers during all weeks except wk 2 and 5, in which there was a tendency \( (P \leq 0.08) \) for higher milk production in CL heifers. Similar to multiparous cows, our data indicate that actively cooling heifers in late pregnancy is effective in improving thermoregulation and production.

**Key Words:** cooling, heifer, milk yield

### 26 The effects of feeding pelleted dried distillers grains with different concentrations of forage on milk production, nutrient digestibility, passage rate, rumen characteristics, and chewing behavior of lactating Jersey dairy cows.

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Particle size or processing of feeds can influence chewing behavior, rumen characteristics, rumen passage rate, and digestibility. Changing particle size is usually achieved through grinding or chopping forages, but processing feed ingredients by pelleting them also changes particle size. Seven rumen cannulated lactating Jersey cows averaging 126 ± 33.3 (Avg ± SD) DIM and 462 ± 36.7 kg of BW were used in a crossover design. The treatments contained \( 15\% \) DM of DDGS in either meal or pellet form along with a diet containing either 45% or 55% forage on a DM basis. The forages used were corn silage, alfalfa hay, and wheat straw. The factorial treatment arrangement was as follows: meal-form DDGS and low forage (LLF), pelleted DDGS and low forage (PLF), meal-form DDGS and high forage (LHF), and pelleted DDGS and high forage (PHF). Both dry matter intake and milk yield were unaffected by treatment \( (P > 0.14) \) averaging 19.8 ± 0.85 kg and 27.8 ± 1.22 kg. Fat yield was unaffected \( (P > 0.32) \) averaging 1.7 ± 0.06 kg, but protein yield was affected by the interaction of forage and DDGS \( (P = 0.081) \); Protein yield was 1.08, 1.05, 0.99, and 1.05 ± 0.035 kg for LLF, PLF, LHF, and PHF respectively. The digestibility of NDF and energy increased by 2.8 and 1.6 units, respectively \( (P < 0.05) \). Rumen mass and passage rate were not affected by treatment \( (P > 0.21) \) and averaged 10.0 ± 0.73 kg of DM and 2.7 ± 0.21%/h. Ruminating time was increased from 415 min to 454 min by increasing the concentration of forage \( (P = 0.08) \). Rumen pH and ammonia also increased due to increasing forage concentration; pH increased from 5.86 to 5.92 ± 0.057 \( (P = 0.04) \) and rumen ammonia increased from 16.8 to 19.1 ± 3.22 mg/dL \( (P = 0.002) \). Outcomes confirm that increasing forage concentration increases rumen pH and rumination time. Our results also indicate that pelleting DDGS does not appear to affect milk production, rumen characteristics, or passage rate but may increase NDF and energy digestibility.

**Key Words:** dried distillers grains with solubles (DDGS), digestibility, rumen passage rate

### 27 Prepartum shifting light circadian rhythm disruptions cause insulin resistance in periparturient dairy cows.

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Circadian clocks function to maintain homeostasis. Disruption of clocks by altering timing of external cues affects glucose metabolism in humans and rodents, with long-term disruption associated with development of metabolic diseases. The objective of this experiment was to analyze the effect of exposure to chronic light-dark cycle phase shifts from 5 weeks before expected calving (BEC) to parturition on glucose tolerance at 2 weeks prepartum and 1 week postpartum in dairy cows. Multiparous Holstein cows \( (n = 16) \) were exposed to 16 h of light and 8 h of dark (CON) or phase shifting (PS) of the start of the light cycle 6 h every 3 d beginning 35 d BEC. Following calving, both treatments were exposed to control lighting through 60 DIM. At 14 d BEC and 7 DIM, intravenous glucose tolerance tests were performed with a dose of 250 mg/kg BW of a 50% dextrose solution. Before dextrose administration, cows were fasted for one hour and baseline blood samples were taken at 15 and 5 min before administration to determine Revised Quantitative Insulin Sensitivity Check Index (RQUICKI). We observed no difference in insulin sensitivity between treatments at both physiological stages via RQUICKI \( (P > 0.05) \). Following dextrose administration, blood samples were taken at 14 time points over 3 h to quantify blood glucose, BHBA, insulin, and NEFA. Linear mixed model analysis indicated no effect of treatment on blood glucose by time point or area under the curve (AUC) for both stages \( (P > 0.05) \). At 14 BEC, there was no difference in baseline values, but insulin AUC was higher in PS compared with CON \( (P = 0.05; 4,302.8 \text{ vs. } 2,386.3 \text{ ng/mL/180 min}) \). At 7 DIM, there was no effect of treatment on glucose AUC \( (P = 0.71) \), but the difference in insulin AUC between PS and CON \( (P = 0.03; 1,052.9 \text{ vs. } 697.1 \text{ ng/mL/180 min}) \) was maintained. There was no effect of treatment on BHBA nor NEFA, but there was an interaction between treatment and time for NEFA at 7 DIM \( (P = 0.007) \). CON vs PS cows produced more milk through 60 DIM \( (42.6 \text{ vs. } 40.3 \text{ kg/d}; P = 0.05) \). Exposure to chronic light-dark PS in late gestation decreased insulin sensitivity in periparturient cows, which may influence milk production.

**Key Words:** insulin sensitivity, glucose tolerance test, circadian rhythm